1. (4 points) Consider a processor with a 2-way set associative cache with a total of 32 words (16 per bank), used for data only. Suppose that a program being executed has a loop that uses four variables $A$, $B$, $C$ and $D$. The program includes a loop in which each variable is read one time during each iteration. Suppose the variables are stored in locations 01c2, 01d5, 0252 and 0fe2 respectively. If the loop is executed 20 times, how many times are each of the variables retrieved from memory.

Explain how to reduce the number of times data must be retrieved from memory by changing the storage location of one variable (specify the variable and its new storage location). How many times are each of the variables retrieved from memory now?
2. (6 points) The simulation output shows a program executing on the processor from section 6 of the course notes. Fill in the blanks below with the information that belongs in each of the blanked out areas in the simulation output.

A. __________________________ B. __________________________ C. __________________________

D. __________________________ E. __________________________ F. __________________________

0000 halt – halt execution
0001 negate – ACC := –ACC
1xxx immediate load – if sign bit of xxx is 0 then ACC := 0xxx else ACC := fxxx
2xxx direct load – ACC := M[0xxx]
3xxx indirect load – ACC := M[M[0xxx]]
4xxx direct store – M[0xxx] := ACC
5xxx indirect store – M[M[0xxx]] := ACC
6xxx branch – PC := 0xxx
7xxx branch if zero – if ACC = 0 then PC := 0xxx
8xxx branch if positive – if ACC > 0 then PC := 0xxx
9xxx branch if negative – if ACC < 0 then PC := 0xxx
axxx add – ACC := ACC + M[0xxx]